JetTorque from HamiltonJet

A TECHNICAL AND COMMERCIAL VIEW OF THE WATERJET PROPULSION MARKET

Waterjet Power Ideal RIB Option

August 2004

Rigid Inflatable Boats (RIBs) have undergone a remarkable growth phase in recent years, not only in terms of physical size, but also in the range of makes and models available, more advanced construction methods and materials, and the different applications RIBs are used for.

Modern RIBs provide a major buoyancy and stability advantage over other hull forms in a wide range of work, patrol and recreation applications. Now many of the world's biggest RIB manufacturers and operators are finding waterjet propulsion enhances these benefits to get the most from their vessels.

Marine Rescue

The biggest marine Search & Rescue organisations worldwide base their successful operations around waterjet-powered RIBs. An RIB's inflated pontoons allow rescuers to safely manoeuvre alongside a vessel without damaging either hull, and people can be pulled from the water over the pontoon with little risk of injury.

When the vessel is lightly laden these pontoons would normally be out of the water, but when heavily laden they provide extra stability and buoyancy to reduce the risk of capsize. In fact, trials on an 18m rescue RIB in The Netherlands found the vessel could safely carry up to 90 people.

Waterjet propulsion enhances the safety features of an RIB. Not only does the waterjet have no dangerous moving parts exposed to people in the water, its unique steering and reverse system provide outstanding manoeuvrability and control in all situations.

This SeaTow rescue/recovery RIB is also used as a pilot boat in Brunswick, GA, USA. It's an Almar RAIV powered by twin HJ274 waterjets.

Waterjet-powered rescue RIBs of the KNRM (The Netherlands)

One of the most important features rescue RIB operators have found is that they can adjust the position of the astern deflector to maintain rapid steering response at all speeds, including very slow or "zero" speed. This is particularly important when carrying out rescue or salvage operations in big swells or breakers where fast steering response is required at slow boat speeds.

Waterjets have become the preferred propulsion option for long-range offshore rescue RIBs, inshore fast rescue RIBs, MOBs, salvage & towing craft, offshore support vessels and RIB daughter-craft.

Patrol & Military

The main benefit of RIBs in patrol and military organisations is load flexibility and their ability to move alongside other vessels without damage, even at high speeds. Waterjets provide excellent propulsive efficiency under all load conditions, outstanding manoeuvrability at all speeds and in close situations, plus increased astern thrust to prevent a boat getting stuck against the hull of a larger vessel – with the associated risk of capsizing.

Waterjets also give patrol and military RIBs the ability to traverse very shallow areas and land directly on the shore without damage to the drive system.

Hamilton Waterjets feature on RIBs in service with the US and UK navies, marine police throughout Europe, and fisheries and environmental patrol agencies in the US.

Recreation

While most RIB tenders and recreational craft are powered by outboards, the waterjet option continues to gain popularity. All the main recreational RIB manufacturers offer waterjet-powered models ranging anywhere up to 10 metres long and 600hp.

A 6m pleasure boat/tender with single Hamilton HJ213 waterjet from Naiad, New Zealand

These stylish RIBs offer a comfortable, quiet and vibration-free ride, safety for swimmers and marine life, plenty of room for passengers and cargo, easy boarding, low maintenance requirements and good looks. What's more, these RIBs have some of the thrilling performance capabilities of jet propulsion such as "Jet Spin" turns, slides and crash stops.

In this Issue...

HamiltonJet's MECS Dynamic Positioning Interface

Dynamic Positioning (DP) systems have been in use in the marine industry for over 40 years. Created as a result of the rapidly expanding oil and gas exploration industry in the 1960s and early 1970s, today vessels from a wide variety of sectors use DPS technology.

HamiltonJet has developed a DPS interface for its MECS electronic control system which integrates the manoeuvring advantages of waterjets with bow thrusters to provide a whole new level of mechanical simplicity and positional accuracy.

Basics of DP Systems

DP can be described as…

A system which automatically controls a vessel's position and heading exclusively by means of active thrust.

In other words, using a ship's own propulsion gear and thrusters to control position and heading. This allows operations at sea where mooring or anchoring is not feasible.

DP can work in two ways…

Absolute – position is locked to a fixed point such as the sea floor.

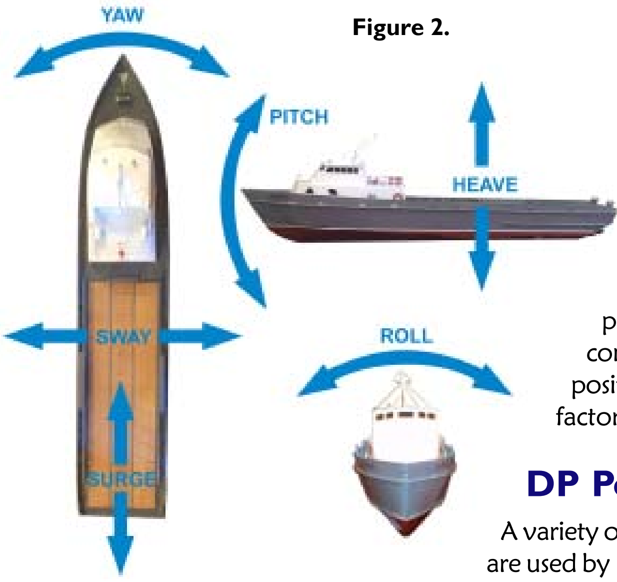
Relative – position is fixed to another moving object such as another ship.

The above definition includes remaining at a fixed location, but also precision manoeuvring, tracking and other specialist positioning abilities.

DP systems must analyse a wide range of input data from various instruments to do with position, heading and environmental conditions, and factor this against the manoeuvring ability and power of the propulsion system/s in order to accurately control the position of the vessel. Figure 1. shows the interrelation of elements of a DP system.

Any vessel (or other object) has 6 freedoms of movement: 3 rotations and 3 translations (see Figure 2.). In a vessel they can be illustrated as roll, pitch, yaw, surge, sway and heave.

Figure 2.



DP is concerned with the automatic control of surge, sway and yaw. Surge and sway comprise the position of the vessel, while yaw defines the vessel heading. Desired "set-point" values for both are entered into the DP system by the operator. Position and heading of the vessel is measured by one or more of a range of instruments, and the DP equipment assesses the difference between the set-point and the feedback then operates to minimise any errors.

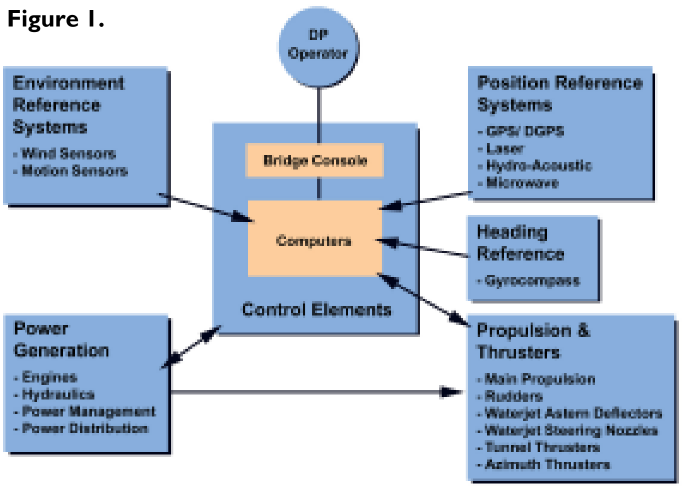
The vessel must be able to control position and heading within acceptable limits in the face of a variety of external forces. If these forces are measured directly, the control computers can apply immediate compensation. For example, compensation for wind forces, or fire monitor forces in a vessel engaged in fire-fighting.

Where such forces affect station keeping, sensors provide direct feedback of these "external" forces to the DP control system and allow compensation to be ordered from the propulsors and thrusters before movement occurs.

In addition to maintaining station and heading, DP may be used to achieve automatic change of position or heading, or both. The DP operator may choose a new position and/or heading using the control console facilities, and also choose the speed at which the vessel is to move and rotate.

NOTE: Roll, pitch and heave motions are not compensated for by the DP control system, but accurate values for roll and pitch are necessary to compensate for movement of position sensors caused by these factors.

Figure 1.



DP Position Inputs

A variety of position reference systems are used by DP systems, but Differential Global Positioning (DGPS) has become the most common option. GPS on its own is not accurate enough for DP purposes, so differential corrections are applied to GPS data by the use of a network of fixed ground-based reference stations at known points.

Some DP operations require the positioning of a vessel relative to another vessel or moving structure. In these situations GPS data can be shared between vessel and structure to gauge the relative position of each. Alternatively, a laser-based position reference system locks on to targets on the structure, from which position must be maintained. Light pulses are sent and received so that range and bearing can be measured.

Reliability is a major consideration with position reference systems. Each has advantages and disadvantages, so a combination is essential to provide high accuracy and reliability.

Modern DP control systems also have the ability to "learn" from past experience to improve station keeping performance. A special filter provides a model of recent position and heading results based on the various sensor inputs, which is then used to improve present performance.

DP Capability

A vessel's main propulsion system and thrusters provide DP capability. In most cases a DP vessel will have tunnel and/or azimuth thrusters forward and aft, working together with a propeller system (controllable-pitch or fixed-pitch) and rudders. Alternatively, a vessel may use azimuth or podded thrusters as the main form of propulsion, giving the advantage of 360° thrust.

More recently, several waterjet-powered oil rig crew/supply vessels have been designed to use DP. This setup offers the advantage of high-speed capability as well as 360° "zero-speed" thrust. This is an ideal propulsion option for these types of high-speed vessel, as waterjets offer significant manoeuvring advantages while simplifying the drive system – fewer thrusters – and reducing maintenance requirements.

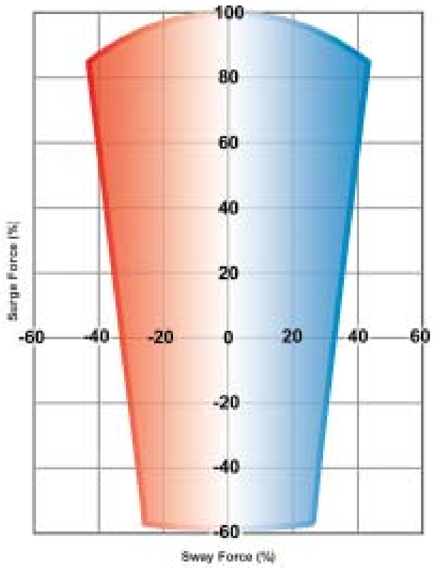
Waterjets & DPS

HamiltonJet developed a Dynamic Positioning Interface (DPI) for its Modular Electronic Control System (MECS), which governs steering, ahead/astern and engine throttle settings.

The DPI module allows MECS to interface easily with a number of proprietary DP systems. Each module is mounted on the bridge and is connected between a control panel and the DPS. One DPI is required for each jet, and performs the following functions (shown in Figure 3):

- Receives azimuth and thrust commands in the form of analogue voltages from the DP system
- Converts the azimuth and thrust commands to waterjet steering, reverse and engine RPM demands and transmits these over the MECS CAN bus.
- Receives MECS steering, reverse and RPM feedback messages from the CAN bus and converts these to azimuth and thrust feedback.
- Sends the azimuth and thrust feedback to the DP system in the form of analogue voltages.

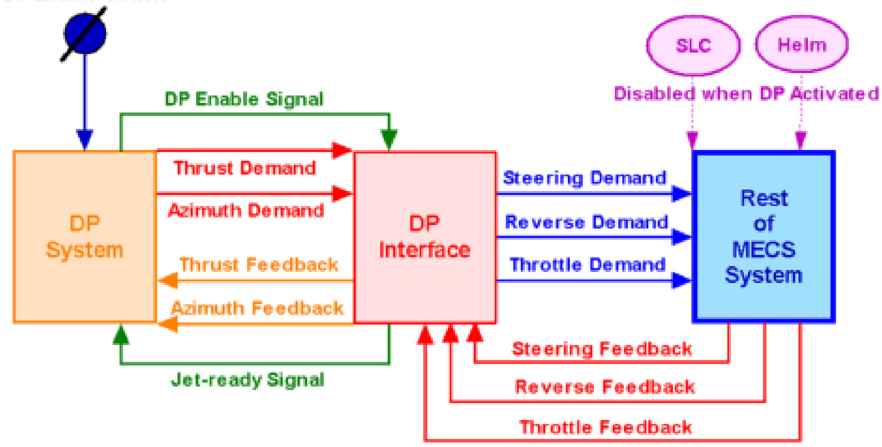
Figure 4. Typical Waterjet Thrust Envelope



One of the key requirements of adapting a DP system for a waterjet-powered vessel is integrating the unique thrust forces provided by waterjets. Unlike azimuth thrusters, which provide equal thrust in all directions, waterjets produce lower reverse and lateral (sideways) thrust than ahead thrust. HamiltonJet supplies DP manufacturers with data on the total thrust available through 360° – see Figure 4.

Also, the waterjet's impellers are constantly engaged in one direction only, with full manoeuvring control (including "zero-speed" station holding) provided by the astern deflector and steering nozzle positions on each waterjet. This removes gearbox actuation requirements and allows for a consistent throttle setting – resulting in much faster positioning response.

Figure 3. MECS DP Interface Functions



Diamond Services, a major crew/supply boat operator in the Gulf of Mexico oil industry, was one of the first to use a DP system on a waterjet-powered vessel. While there are several propeller driven crew boats using DPS in the Gulf of Mexico, Diamond Services recognised the added advantages of combining the system with the unique manoeuvring capabilities of waterjets.

A HamiltonJet MECS DPS interface was installed in the 170-foot Diamond Services crewboat "Miss Julie" in June 2002. Figure 5. shows the control console of Miss Julie with the MECS controls in the foreground and DPS controller at the top of the picture.

Initial trials of the system were completed in the Gulf of Mexico before the vessel entered service. In all trial situations the vessel was able to maintain a very accurate position for both bow and stern.

Figure 5. Miss Julie Helm

As the DP cycle of monitoring and correction is repeated many times each second, the vessel is able to maintain a set position and orientation for several hours without operator input. This is important for crew/supply boats, which are required to hold station at oil platforms while supplies are unloaded. Expensive and dangerous collisions can occur due to human operator error in these situations, a risk virtually eliminated with DPS.

Following the success of Miss Julie, several other waterjet-powered crewboats were fitted with DP systems. HamiltonJet's MECS interface can be adapted to work with most commercially available DP systems.

Celebrating 50 Years of the Hamilton Waterjet

Above: A line up of Hamilton jetboats spanning 48 years from 1956 to 2004.

Right: Jon Hamilton, son of the late Sir William Hamilton, reaches the top of the Waimakariri River Gorge in the Whio III replica boat, built in 1957.

HamiltonJet's 50th anniversary celebrations kicked off in February 2004 when over 60 delegates from the company's worldwide sales network gathered for a week-long conference.

The opening night featured a gala dinner, where HamiltonJet staff and guests were entertained with a "This is Your Life" dedication to Jon Hamilton, a company icon and jetboat adventurer made famous by his boating expeditions around the world. Guests included Sir Edmund Hillary, with whom Jon shared river adventures in India, Nepal and New Zealand.

Following factory tours and workshops the next day, the Distributor delegates and HamiltonJet personnel travelled to Rotorua for the remainder of the event.

Anniversary Regatta

The Waimakariri River in Canterbury, New Zealand, played an integral role in the development of the Hamilton Waterjet during the 1950s and 60s, and remains the world's most jet boated river. So it was only fitting for the river to host a regatta to celebrate 50 years of jet boating in New Zealand.

Eighty jet boats and more than three hundred people turned out on Sunday

29 February 2004 for the 45 km run up through the Waimakariri Gorge. The line-up of boats was representative of all the styles of jet boats produced since the late 1950s through to brand new models.

New Test Boats for HamiltonJet R&D

HamiltonJet continues to lead the industry with new developments in waterjet technology and design. A key component of the company's R&D is its test boat program, which now includes two specialist testing vessels for both mechanical and control system design improvements.

The new 9.5m purpose-designed mechanical test boat (pictured on left) features a fully computerised data recording system to measure performance and efficiency of different waterjet component designs and in a variety of situations. The vessel features twin 454 Crusader engines, one coupled to a complete waterjet for general purpose manoeuvring, while the other drives the test unit (no steering or reverse control). Panels in the hull and transom allow the test unit to be removed and new intake and outlet designs to be installed with ease. Ballast tanks in the bow and on the stern allow for the waterjets to be tested under a variety of trim conditions.

The Advanced Controls Demonstrator vessel (on right) is the previous mechanical test boat hull, refitted with twin HJ213 jet units coupled to 350 Chev engines along with a new wheel house and helm station. It is used to test and demonstrate new electronic manoeuvring control systems being developed at HamiltonJet.

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